Massachusetts Institute of Technology Instrumentation Laboratory Cambridge, Massachusetts

LUMINARY Memo #123

To:

Distribution

From:

D. Eyles

Date:

18 November 1969

Subject:

More About Delta-Guidance

Delta-guidance is running in AMELIA 11 (as also in some of the earlier revisions) which in other respects is just like LUMINARY 130, which was just released as 1C.

Here are the patches required:

location	old	new	symbolic	new
05, 2310	bad word	03641	ECADR	TTT/8
31, 2213	62325	63770	BZMF	31, 3770
31, 3770	unused	34755	CA	ZERO
31, 3771	unused	55610	TS	FWEIGHT
31, 3772	unused	55611	TS	FWEIGHT +1
31, 3773	unused	12325	TCF	THDUMP

On the next page is given the initialization which is different from that for LUMINARY 130. See Luminary Memo #115 for a description of the new parameters. Note that DELTTTAP has been eliminated since the initial TGO for P64 equals P63's final TGO. The values given are Allan Klumpp's latest. The only number not given is RPCRTIME which should be set equal to TENDBRAK to make the LR antenna reposition at high-gate.

DATA
~
-
-
_
-
7
111
0
-
DEPENDENT
ш
0
-
نلا
0
-
7
DES I GN
0
-
V
LU
0
-
-
0
-
-
-
()
111
الما
7
TRAJECTORY
-
OX.
-
-

16N	(ment)	D 41 4000051 Et 10 10 VI			-
2D -4.0261253 E + 40-24 RICKG -4.0261253 E + 6 002475 77 72 72 72 72 72 72 72 72 72 72 72 72		U 11-01-1371 Et 10-10 VI	1.69099951 E+ 3 0024	1 00	-
2D - (4.36270484 E+ 58-24 R 1626 + 4.46270484 E+ 5 002475	RIGNX	D -4.02612533 E+ 4B-24 RIGX	4.02612533 E+ 4 0024	3 77	N
2D036601937	RIGNZ	-4+36270484 E+ 58-24 RIGZ	4.36270484 Et 5 0024	5 77	42
20EC 20EC 20	KIGNX/B4	038601937 K	6.17630999 E- 1 00.24	7 76	3
20 - 1)66407587	KIGNY/88	EC	25	1 00	00
20 +3.04302 E + 18-24 + 4.2 9764318 E + 2 002404 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	8	156402587 K	4.10000000 E+ 2 0025	3 72	11
20 +2.93643502 E+ 18-24 -2.9361128 E+ 002406 20 -9.3601128 E+ 002406 20 -9.3601128 E+ 002406 20 -9.3601128 E+ 002406 20 -9.3601128 E+ 002406 20 -0.27549803 E+ 08-7 20 -0.27549803 E+ 002406 20 -0.27549803 E+ 002406 20 -0.27549804 E+ 0 002406 20 -0.34411788 E+ 1 002426 20 -0.3441788 E+ 1 002446 20 -0.344178 E+ 18-8 20 -0.34404999 E+ 10 000447 20 -0.344049999 E+ 10 000447 20 -0.344049999 E+ 10 000447 20 -0.3440499999 E+ 10 000447 20 -0.34404999999999999999999999999999999999	RIG	+3.79762136 E+ 28-2	3.79762136 Et 2 0024	2 00	19
20 -4.5271878 E + 48-24 -4.5271878 E + 0.02406 77 20 -9.35081728 E - 0.02-24 20 -9.2562790 E - 1 0.02414 00 20 -5.51227250 E - 30-7 20 -5.51227250 E - 30-7 20 -5.51227250 E - 1 0.02426 77 20 -5.51227250 E - 2 0.02426 77 20 -5.51227250 E - 1 0.02426 77 20 -5.51227250 E - 2 0.02426 77 20 -5.51227250 E	APTG	+2.93043502 E+ 18-2	2.93043502 E+ 1 0024	70 4	72
2 D - 9.35081128 E + DB-24	BRTG	-4.52071878 E+ 48-2	4.52C71878 E+ 4 0024	17 9	21
20 +5,46926427	PIG	-9.39081728 E+ 08-2	9.39081728 Et 0 0024	0 77	55
20 +9.5627990 E- 33-7 +9.50627990 E- 1 0002414 0C 20 -5.512272526 E- 38-7 +5.51227256 E- 1 0002416 77 20 -5.51227256 E- 2 - 1 000242 01 20 -2.6579456 E- 1 - 2.12654434 E- 1 0002424 01 20 -2.6577456 E- 15.12857438 E- 1 0002432 77 20 -3.3441788 E- 45.3579034 E- 3 002436 77 20 -3.441788 E- 24.34578034 E- 3 002436 77 20 -4.38918454 E- 24.38918454 E- 2 002446 01 20 -4.244648 E- 24.38918454 E- 2 002446 01 20 -4.2454338 E- 14.38918454 E- 2 002446 01 20 -4.45871904 E- 14.109765 E- 6 002446 01 20 -4.45871904 E- 14.990455 E- 3 002446 01 20 -4.45871904 E- 14.990455 E- 5 002456 01 20 -4.45871904 E- 14.990455 E- 5 002457 01 20 -4.45871904 E- 14.990455 E- 5 002457 01 20 -4.45871904 E- 14.990455 E- 5 002457 01 20 -4.45871904 E- 14.990456 E- 5 002457 01 20 -4.45871904 E- 14.990456 E- 5 002457 01 20 -4.45871904 E- 14.990456 E- 5 002457 01 20 -4.45871904 E- 14.99046	RTG	+5.46925427 E- 18-	5.46925427 E+ 1 0024	2 00	15
2D -6.27549803 ± + 0b-7	PTG	+9.50627990 E- 38-	9.50627990 E- 1 0024	4 00	14
20 -5.5122755 E - 38-7	RIG	-6.27549803 E+ 0B-	6.27549803 Et 2 0024	6 76	43
20 +5.97C04660 F- 2 2	PTG	-5.51227250 E- 38-	5.51227250 E- 1 0024	0 77	32
2D +6.14681267 E 3	ABRIGX	+5.87004660 E-	1.14649347 E+ 0 0024	2 01	14
20 - 2.6257945C E - 1 - 5.1285548 E + 0 00243C 77 20 - 3.441178 E - 4 - 6.53148024 E - 3 20 - 7.466667726 E - 2 20 - 7.466667726 E - 2 20 - 7.466667726 E - 2 20 - 7.4846498 E - 2 20 - 7.4846498 E - 2 20 - 7.4846498 E - 2 20 - 1.38918454 E - 1 20 - 1.3891852 E - 3 20 - 1.459176 E - 1 20 - 1.3891853 E - 1 20 - 1.3891853 E - 1 20 - 1.3891853 E - 1 20 - 1.382189 E - 6 20 - 1.382189 E - 1 20 - 2.3768853 E + 18-8 20 - 2.4734776 E + 18-8 20 - 2.3768853 E + 18-8 20 - 3.04799999 E - 2 20 - 3.04799999 E - 2 20 - 3.04799999 E - 2 20 - 4.3595653 E + 18-8 20 - 4.3576966 E + 48-17 TENDBRAK 20 - 2.3768066 E + 48-17 TENDBRAK 20 - 2.3768063 E + 49-17 TENDBRAK 20 - 2.3768063 E + 40-17	AAPIGX	+6.14681267 E-	1.20054934 E- 1 0024	4 00	24
20 -3.34411788 E- 4	ABRTGZ	-2.6257945C E-	5.12850488 E+ 0 0024	9 9	21
20 +1.38353481 E- 1	()	-3.34411788 E-	6.53148024 E- 3 0024	77	25
20 +7.66607126 E - 2 20 +7.66607126 E - 2 20 +7.646408 E - 2 20 +7.4846408 E - 2 20 +7.4846408 E - 2 20 +1.38918454 E - 2 20 +1.2991855 E - 3 20 +1.4581704 E - 1 20 +1.4581704 E -	O	+1.38353891 E-	6.18489691 E- 3 0024	2 04	17
20 -9.74846498 E- 2 20 +2.45146884828 E- 1 20 +1.416885674 E- 2 20 +1.389184828 E- 1 20 +1.389184828 E- 1 20 +1.389184828 E- 1 20 +1.389184828 E- 1 20 +1.389184828 E- 2 20 +1.389184582 E- 3 20 +1.45871904 E- 1 20 +1.458719192 E+ 18-8 2236 22457 22467 224	10	+7.66667726 E-	3.42727181 E- 3 0024	4 02	36
20 +2.61468828 E = 1	()	-9.74846498 E-	4.35790344 E- 3 0024	74	15
2D +1.38918454 E- 2 +1.89518398 E- 6 002442 000 2D +1.29902552 E- 3 +1.103507036 E- 6 002444 000 2D +1.45871904 E- 1 +1.45871904 E- 1 +1.458719056 E- 6 002456 004 2D +1.45871904 E- 1 +1.45871904 E- 1 +1.458719056 E- 7 002456 004 +1.499004586 E- 5 002457 04 +1.499004687 E- 18-8 +1.4990004687 E- 18-8 +1.499000487 E- 18-8	()	+2.61468828 E-	1.16885674 F- 2 0024	10	97
20 +8.21245308 E- 1 20 +8.21245308 E- 1 20 +7.59909552 E- 3 20 +7.59909552 E- 3 21 +1.45871904 E- 1 20 +1.45871904 E- 1 21 -8.88576611 E+ 08-8 21 0 +3.94784176 E+ 18-8 21 0 +3.9526514 E+ 18-8 21 0 +2.3768853 E+ 13-8 21 0 +2.3768853 E+ 13-8 21 0 +2.3768853 E+ 13-8 21 0 +1.88211192 E+ 18-8 21 0 +1.88211192 E+ 18-8 22 46 22 46 22 46 22 46 22 46 22 47 24 47 24 47 24 47 24 47 24 47 24 47 24 47 24 47 24 47 24 47 24 47 24 47 24 47 24 47 24 2	0	+1.38918454 E-	1.89518398 E- 6 0024	2 00	52
20 +7.59909552 E - 3	APTG	+8.21245308 E-	1.12037738 E- 4 0024	4 32	03
20 +1.45871904 E- 1	BRIG	+7.59909552 E-	*03670056 E- 6 0024	9	7
10 -8.88576611 E+ 08-8	APTG	+1.45871904 E-	.99004586 E- 5 0024	040	2
10 +3.94784176 E+ 18-8 10 -8.88576611 E+ 08-8 10 -8.88576611 E+ 08-8 10 +3.94784176 E+ 18-8 10 +3.94784176 E+ 18-8 10 +3.94784176 E+ 18-8 10 +3.9526514 E+ 18-8 10 +2.3768853 E+ 18-8 10 +1.38211192 E+ 18-8 10 +1.38211192 E+ 18-8 10 +1.55253531 E+ 18-8 10 +1.520303050 E+ 48-17 TENDBRAK	I	-8.88576611 F+ 08-	024	2 76	
10 -8.88576611 E+ 08-8		D +3.94784176 E+ 18-	024	3 04	
10 +3.94784176	1	D -8.88576611 E+ 08-	024	4 76	
10 +3.05926514 E+ 18-8 10 +2.37689853 E+ 18-8 10 +2.37689853 E+ 18-8 10 +2.37689853 E+ 18-8 10 +1.38211192 E+ 18-8 10 +1.59353531 E+ 18-8 10 +1.5593531 E+ 18-8 10 +1.599999 E- 28- 7 DOWNCRIT	CAP	D +3-94784176 E+ 18-	024	5 04	
10 +2.37069853 E+ 18-8 10 +3.05926514 E+ 18-8 10 +1.38211192 E+ 13-8 10 +1.59353531 E+ 18-8 10 +1.593531 E+ 18-8 10 +1.593531 E+ 18-8 10 +1.593531 E+ 18-8 10 +1.593531 E+ 18-8 10 +1.5	OF B	D +3.05926514 E+ 18-	024	6 03	
10 +3.05926514 E+ 1B-8 10 +2.37068853 E+ 13-8 10 +1.38211192 E+ 13-8 10 +1.38211192 E+ 13-8 10 +1.59353531 E+ 18-8 10 +1.559353531 E+ 18-8 10 +1.59353531 E+ 18-8 11	m	D +2.37069853 E+ 18-	024	7 02	
1D +2.37068853 E+ 13-8 1D +1.38211192 E+ 13-8 1D +1.59353531 E+ 13-8 1D +1.59353531 E+ 18-8 1D +1.59953531 E+ 18-8 1D +1.59999 E- 28- 7 DUWNCRIT	1	D +3.05926514 E+ 1B-	024	03	
10 +1.38211192 E+ 13-8 10 +1.59353531 E+ 18-8 10 +1.382211192 E+ 18-8 10 +1.382211192 E+ 18-8 10 +1.382211192 E+ 18-8 10 +1.35253531 E+ 18-8 10 +1.55253531 E+ 18-8 10 +1.552531 E+	4	D +2.37068853 E+ 18-	024	1 02	
1D +1.59353531 E+ 1B-8 1D +1.88211192 E+ 18-8 1D +1.88211192 E+ 18-8 1D +1.5935331 E+ 18-8 002464 02 002465 01 002465 01 002465 01 002465 01 002467 00 002467 00 002467 00 002467 00 002467 00 002470 77 1D +1.62030000 E+ 4B-17 TENDBRAK +1.62000000 E+ 2 003424 00 003424 003424 00 003424 003424 00	OEB	+1.38211192 E+ 13-	024	2 02	
10 +1.88211192 E+ 18-8	E H	+1.59353531 E+ 18-	024	3 01	
10 +1.55253531 E+ 18-8 DEC	u.	+1.88.211192 E+ 18-	024	4 02	
DEC 2236 DEC 2236 1D +0.0000000 E+ 08-10 UPCRIT +0.00000000 E+ 0 002467 00 IT 1D -3.04799999 E- 28- 7 DUWNCRIT -3.04799999E+ 0 002470 77 AK 1D +1.62039000 E+ 48-17 TENDBRAK +1.62000000 E+ 2 003424 00 PR 1D +2.2272 FLO +2.84908594 E+ 4 003426 04	SCOFAP	+1.55253531 E+ 18-	024	5 01	
1D +0.06000000 E+ 0B-10 UPCRIT	FCODEN	2236	024	9 04	
SRAK 1D +1.620309000 E+ 48-17 TENDBRAK +1.62000000 E+ 2 003423 -03 APPR 1D +2272	IPCRIT	+0.00000000 E+ 08-10 UPC	0.0000000E+ 0 0024	7 00	
3RAK 10 +1.62030000 E+ 48-17 TENDBRAK +1.6200000 E+ 2 003423 - 03 4PPR 10 +2 20200000 E+ 20-17 TENDADDD +2.84908594 E+ 4 003424 00 411 +2.84908594 E+ 4 003426 04	0	-3.04799999 E- 28- 7 DOWNCR	T -3.0479999E+ 0 0024	17 0	
APPR 10 + 2272 FLO FLO +2.84908594 E+ 4 003424 00425 04	TENDSRAK	+1 62000000 E+ 48-17 TENDER	x +1.6200000 Et. 2. 0034	3 03	1
31T + 2.272 + 4 003426 04		+1 -0200000 ET 90544 153000 +2 2600000 Et 30517 TENDAD	12 2 2 2 2 4 1 0034	4 00	
3770 367600 7 13 03007670 6.	1 2	+ 2272 FLO	+2.8490.8594 E+ 4 0034	6 04	
CHCRIT + 2347 FH	2	+ 2347	2.94249859 E+ 4 0034	5 0445	

Runs on AMELIA have disclosed several interesting facts:

- (1) Forward redesignations of the landing site, for instance a 10000 foot downrange noun 69 input at the start of P64, can cause pulse-outs, as well as cause the LM to pitch forward from the vertical. Large backward redesignations also cause pulse outs, but this is not unexpected.
- (2) A lateral velocity noise spike at TGO = -50 in P64 of 1.5 f/s after incorporation causes oscillations in roll. This is the problem cured for LUMINARY 1A by adding coefficients containing LEADTIME to the guidance equation (see Luminary Memo # 97). Maybe crafty choosing of A and B will clear this up, averting the necessity of putting back LEADTIME, which would be hard.
- (3) It is confirmed that large downrange redesignations in P63 (via noun 69) cost no fuel 50000 feet at the start of the burn was tried and actually less propellant was used.

Some plots are appended: first and second the thrust and pitch profiles of the nominal run for the interesting ways they differ from the old style, and third the roll (strictly CDUZ) in response to the lateral velocity noise spike.





